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THE IMMATURE STAGES OF *ALOPHORA LEPIDOFERA* (MALLOCH) (DIPTERA: TACHINIDAE), A NATIVE PARASITE OF LYGAEIDAE (HEMIPTERA) IN AUSTRALIA

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Abstract

The immature stages of *Alophora* (*Mormonomyia*) *lepidofera* (Malloch) are described and figured for the first time. The caudal spiracles of the third instar larva have structures not previously recorded on those of other tachinids. The life cycle of this parasite is described in part and discussed along with its significance as a lygaeid parasite in Australia.

Introduction

A tachinid fly identified as *Alophora* (*Mormonomyia*) *lepidofera* has been recorded as an endoparasite of the Lygaeidae *Nysius vinitor* Bergroth, *Nysius clevelandensis* Evans (Attia 1973), and has since been reared from another lygaeid, *Oxycarenus luctuosus* Montrouzier and Signoret. The specimens key to *A. lepidofera* in Malloch's (1929) key, match Malloch's description and illustrations (1930) and were compared with other specimens of *A. lepidofera* in the British Museum. However, the species name must be regarded as provisional in the absence of a revision of this species group and comparison with type material (Crosskey pers. comm. 1973). This fly has so far only been reported from New South Wales and its full distribution is not yet known.

Crosskey (1973) treats the cosmopolitan *Hyalomya* group as a subgenus of *Alophora* and places some Australian species of *Alophora* within it. In this sense, the genus *Alophora* is large and well represented world-wide with some recorded as parasites of Lygaeidae or other small Heteroptera (Thompson 1951, Eyles 1963, Crosskey 1973 and Arnaud 1978). Fourteen species of *Alophora* recorded from Australia are listed by Crosskey. Very few of these have hosts recorded for them and there are, as yet, no other descriptions of immature stages. *Alophora aurieventris* Curran is recorded by Crosskey (*loc. cit.*) as a parasite of the pyrrhocorid *Dysdercus sidae* Montrouzier. Malipatil (1979) records *Alophora nigrihirta* (Malloch) parasitizing the lygaeid *Paraeucosmetus woodwardi* Malipatil. He also notes for other lygaeids, a similar larva from

Horridipamera robusta Malipatil, an *Alophora* sp. reared from *Arocatus rusticus* (Stal) as well as *Alophora ?lepidofera* from *Nysius vinitor* in Queensland.

Nysius species are widely distributed in all States of Australia (Woodward 1964) and frequently cause serious damage to summer crops (see Attia 1974). Evans (1936) mentions that in all *Nysius* pest species, outbreaks appear to be associated with prolonged dry summers but that in Australia dry summers are not always accompanied by outbreaks of *Nysius*. Thus, he concluded that other factors, partly biological, must be concerned in population fluctuations. Parasitism of *Nysius* spp. by *A. lepidofera* in New South Wales was recorded at a peak of 62% (Attia 1973) and could therefore be a mitigating influence on *Nysius* populations in some seasons. This paper presents known information on *A. lepidofera* and gives descriptions of the immature stages to assist further investigations into its potential in the biological control of *Nysius* species in Australia.

Alophora lepidofera (Malloch)

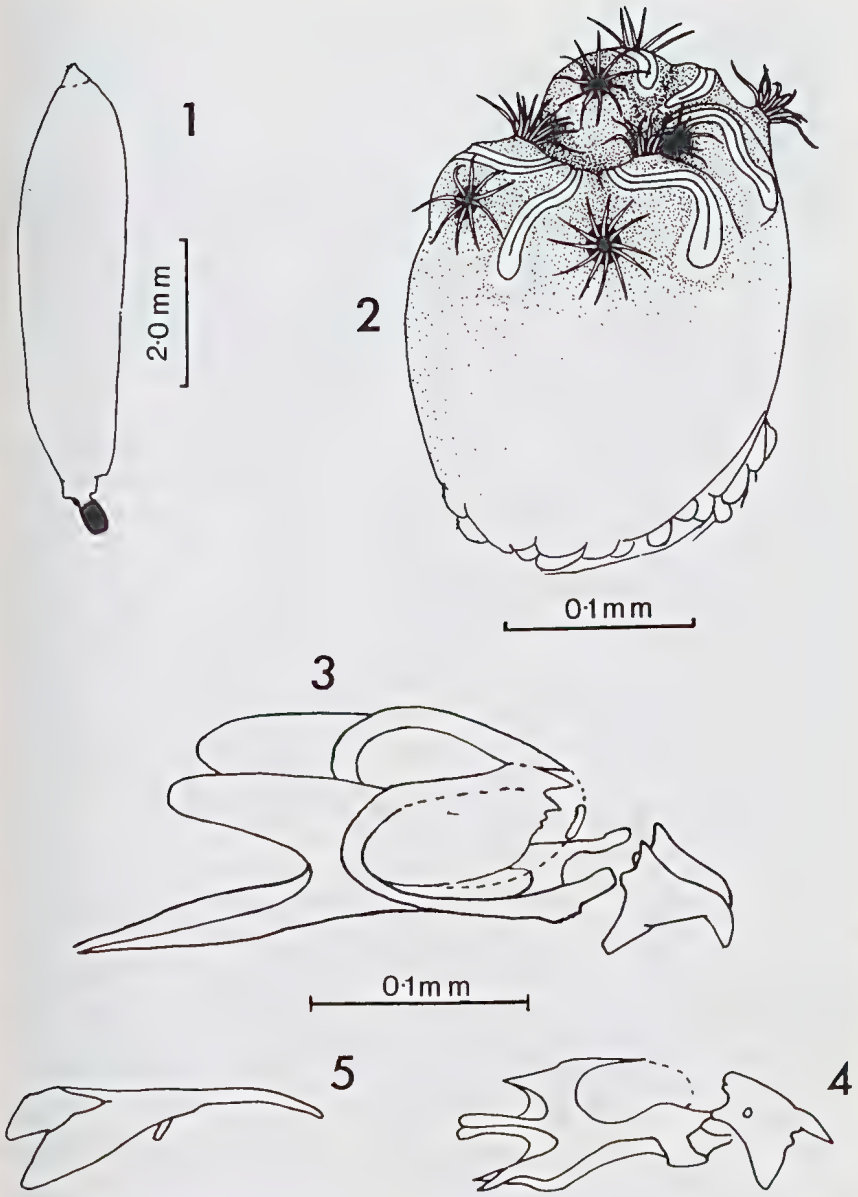
LARVA

There are three larval instars of *A. lepidofera* within the host. The first instar description is based on three specimens, the second instar on nine specimens and the third instar on seventeen specimens, dissected from *Nysius vinitor* (with one specimen from *Oxycarenus luctuosus*) and mounted on microscope slides. Further material retained in 70% alcohol as well as puparia from reared adult flies were also examined. All specimens are held in the Biological and Chemical Research Institute collection at Rydalmere.

First instar: Length 0.6-1.0 mm. Body semi-translucent white, cylindrical, slightly claviform tapering to blunt cylindrical posterior; with head and ten discernible body segments. Caudal spiracles small, separate, single lobed. Other spiracles not apparent. Pseudocephalon ringed with three to four loose rows of fine spinules; body segments I-II smooth; segments IV-IX inclusive each with six to seven transverse rows of small rounded tubercles anteriorly on the ventral third of segment's circumference; segment IX ringed posteriorly with three to four loose rows of fine spinules; segment X (caudal segment) sparsely covered with fine spinules excepting the bisected circular anal orifice. Buccopharyngeal armature simple, brown and smooth (Fig. 5).

Second instar: Length 1.5-2.0 mm. Body similar to third instar (Fig. 1). Segmentation indistinct. Caudal spiracles separate, rugose, bi-lobed, situated on apex of slightly raised, broad, unsclerotised posterior process; other spiracles absent. Last body segment ringed with five to seven irregular rows of spinules. Triangular spinule patch ventral to the spiracles. Buccopharyngeal armature (Fig. 4) brown, rugose, with slender oral hooks fused postero-ventrally to large dental and accessory sclerites. Pharyngeal sclerite long, broad; cornua small.

Third instar: Length 3.5-5.5 mm. Body robust fusiform (Fig. 1), creamy white with brown gut contents visible; segmentation indistinct. Integument smooth, caudal two segments narrower than preceding segments. Anterior spiracles



Figs 1-5. *Alophora lepidofera* (Malloch) larva: (1) third instar; (2) caudal spiracle of third instar; (3) buccopharyngeal armature of third instar; (4) buccopharyngeal armature of second instar; (5) buccopharyngeal armature of first instar.

absent. Caudal spiracular processes fused, globose-cylindrical, black, smooth with double band of small rounded tubercles near base; three raised slightly sinous spiracular slits and four slightly raised pores each side with nine to eleven pale setiform protrusions from each pore. Broad triangular patch of six to seven spinule rows ventral to spiracle; single row of spinules around spiracle. Anal orifice longitudinally slit-like, about one third as long as basal spiracular width, located nearly twice its length ventral to the spiracle, bordered each side by two infolded semicircular brown plates. Mildly raised integument tubercle each side of anus. Buccopharyngeal armature (Fig. 3) without apparent dental or accessory sclerites. Hypostomal sclerites fused to pharyngeal sclerites; dorsal cornua broader and shorter than ventral cornua in lateral view; cornua dark brown, oral hooks and hypostomal sclerites black. Infra-buccal area with patch of approximately twenty rows of spinules increasing in size anteriorly; ultra-buccal area lined with approximately seven rows of fine spinules; anterior oesophagus lined with rows of small tubercles.

Puparium: Length 3.2 ± 0.2 mm. Elongate-oval, slightly bulbous anteriorly, dark red-brown. Spiracular process black, occasionally yellow on spiracular slits; produced posteriorly to about 0.3 mm.

Life cycle

Alophora lepidofera was cultured in the laboratory, for only one generation, with *Nysius vinitor* and *N. clevelandensis* as the hosts. Copulation was observed within 24 hours of emergence and mostly took place in the morning. It commences with the male mounting the female, grasping her head with his fore legs and her thorax with his mid and hind legs. During copulation the female pushes her head upwards and the male pushes it downwards resulting in rhythmic up and down movement. The flies neither flew nor fed during copulation. Each pair observed copulated two to three times and copulations lasted between 10 and 46 minutes.

Emerged flies fed on dilute honey solution placed in the cages and a mated female fly was dissected daily from one to four days after copulation. The most mature eggs found at the apices of the ovaries were elongate-oval shaped and translucent white. No hatched larvae were found in fly dissections and the lack of progressively developing eggs in the uterus suggests that *A. lepidofera* is probably oviparous as are its close relatives *Hyalomya* species (Clausen 1940). The state of the ovaries was very similar between the different days of dissection. This, and the short adult life (six to eight days at 25 ± 2°C), indicates that *A. lepidofera* adults mature rapidly after emergence.

Oviposition was not observed in the laboratory. Larvae were dissected from both host species placed with mated female flies but the oviposition method and fecundity remain unknown.

First, second and third instar larvae were all found with their posterior end just in the metathoracic segment with the anterior end aligned along the abdomen. Third instar larvae are attached to a metathoracic trachea close to the spiracle by means of a respiratory funnel. All three instars are metapneustic

and most gas exchange is probably through their posterior spiracles because of the chitinous sheath the host forms encasing the larva. The respiratory funnel is nearly half the full grown larval length. It usually contains remains of the second instar buccopharyngeal armature and also occasionally that of first instar. This suggests that all three larval instars have a respiratory funnel.

The main host tissue eaten is the fat body in both sexes and the ovaries in females. Parasitism by *A. lepidofera* therefore renders female hosts incapable of reproducing. Adult females are more often hosts to the extent that 95.2% of parasites were from females, 4.8% from males and none was from nymphs (Attia 1973). Preference for female hosts is not uncommon in Tachinidae and is also noted in *Hyalomya aldrichi* (Clausen 1940).

Multiple parasitism by *A. lepidofera* has been observed only once, when one large and two small *A. lepidofera* larvae were dissected from a female *N. vinitor* at Tamworth, N.S.W. Mermethid nematode worms have been found on rare occasions in the same *N. vinitor* as larvae of *A. lepidofera.* It is not known in these cases of multiple and mixed parasitism whether or not the parasites reach maturity.

Larvae emerge from female hosts, through the intersegmental region between the 7th and 8th sternites in females with the end segments pushed upwards perpendicular to the abdomen. In male hosts the larvae emerge through either the end of the abdomen or through a fracture between prosternite and mesosternite. The hosts die within two hours of parasite emergence. On emergence the larvae are active, move rapidly and form puparia within approximately five hours. The observed larvae did not seem to seek concealment and pupated on the surface of light loam soil, partly hidden under the soil surface or in the heads or on the leaves of sunflowers in the cages.

Mature larvae left their hosts and pupated ten days after the latter had been exposed to mated female flies. The pupal stage occupies ten days for female flies and nine days for male flies. The life cycle of *A. lepidofera* in the laboratory at 25 ± 2°C therefore took about 21-25 days to complete, allowing five days for adult maturity and oviposition. This period as a pupa is consistent with that of five to seven days for *H. aldrichi* in summer (Clausen 1940) and of eight days for *Alophora pusilla* Meig (Eyles 1963). Nothing is known of the life cycle duration in the field or whether a quiescent stage exists. All field records of parasitism so far have been in spring and summer months between August and February. *Nysius vinitor* and *N. clevelandensis* overwinter as adults and it is possible that *A. lepidofera* has an extended larval duration inside the host during winter months.

Discussion

The first instar larva (see description) is 'tachiniform' (Clausen 1940) and there are some structures which allow speculation as to its entry into the host. The thin, unpigmented skin suggests that the larvae are not long, if at all, outside their hosts. However, the patches of small tubercles on the ventral surface of body segments are in the form of "creeping welts" which suggest

that the larvae are capable of moving on a surface. The buccopharyngeal armature does not seem as robust as those found in larvae such as *Centeter cinerea* (Clausen *et al.* 1927) which are known to penetrate an adult host's integument from the outside. The single smooth hook of *A. lepidofera* appears better suited to tearing a tracheal wall.

The respiratory funnel, arising from the host's main trachea near the metathoracic spiracle, is evidently present (see life cycle) during the first instar. Therefore, the first instar larva possibly either: enters the host through this main trachea, initiating a primary respiratory aperture; or seeks this position to penetrate the trachea initiating a secondary respiratory aperture (Keilin 1944) if it hatches from an egg oviposited within the host. The latter seems unlikely to the authors because of the lack of sclerotised armament on the caudal end, often found in larvae which form a secondary respiratory aperture (Clausen 1940, Keilin 1944). However, this cannot be dismissed considering that the last abdominal sternite of female adults is modified into a sclerotised beak (illustrated by Malloch 1930) which could possibly serve to puncture the integument during oviposition.

The posterior spiracles of third instar larvae of *A. lepidofera* are distinct from those of other tachinid larvae examined and from those previously described, in having pores with setiform protrusions. These pores are probably analogous to the tubercles possessing hydrophobic hairs found on the spiracles of other Schizophora larva. However, their function implied by this analogy, of preserving spiracular access to air at a liquid interface seems anomalous considering the spiracular encasement within a respiratory funnel. Examination of the spiracles at high magnifications with both a scanning electron microscope and a light microscope shows the pores to be quite deep and the setiform protrusions to arise from a common membranous base within the pore.

The immature stages described and figured show negligible variation in morphology amongst the specimens examined. This indicates that morphological variation, if found in similar larvae, can be interpreted as interspecific rather than intraspecific. In support of larval differences indicating different species in Tachinidae, Thompson (1922) reported three distinct larval types from different hosts corresponding to adult flies identified as conspecific by a taxonomist working on Tachinidae at that time. The adults were subsequently determined to be three distinct species. It is possible that the larvae of other *Alophora* species resemble those of *A. lepidofera*, yet differ in some of the characters used to describe *A. lepidofera.*

It is not uncommon for species of *Alophora* to have more than one host (Crosskey pers. comm. 1973) and *Alophora lepidofera* may have potential hosts other than the three already recorded. The Australian *Nysius* species are likely to have other tachinid parasites and the sampling areas in New South Wales (Attia 1973) represent only part of their range, although in Attia's dissections and approximately 26,000 *Nysius* dissections done from 1975 to 1980 (N. W. Forrester pers. comm.) *A. lepidofera* was by far the most abundant parasite.

A tachinid first instar larva in the 'planidium' category of Clausen (1940) has been dissected from *Nysius vinitor* at Tamworth N.S.W. This type of larva differs greatly from the 'tachiniform' first instar of *A. lepidofera*, being eight segmented with dark pigmented plates covering its entire integument and having more complex buccopharyngeal armature. Attia (1973) found no 'planidia' in his *Nysius* dissections and only on two subsequent occasions have these larvae been found (N. W. Forrester pers. comm.). Considering their rarity and the lack of mature larvae different from those of *A. lepidofera*, the authors suspect that they are of a species which does not normally invade *Nysius vinitor* as its host.

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References

Attia, F. I., 1973. *Alophora lepidofera* (Diptera: Tachinidae) a native parasite of the Rutherglen bug *Nysius vinitor* and the grey cluster bug, *Nysius clevelandensis* (Hemiptera:Lygaediae) in Australia. *J. Aust. ent. Soc.* 12: 353-354.

Attia, F. I., 1974. Laboratory evaluation of insecticides against *Nysius vinitor* Bergroth and *Nysius clevelandensis* Evans (Hemiptera: Lygaeidae). *J. Aust. ent. Soc.* 13: 161-164.

Arnaud, Paul H. Jnr., 1978. A host-parasite catalog of North American Tachinidae (Diptera). *U.S. Dept. Agric. Misc. Pub.* 1319: 860 pp.

Clausen, C. P., King, J. L. and Teranishi, C., 1927. The parasites of *Popillia japonica* in Japan and Chosen (Korea) and their introduction into the United States. *U.S. Dept. Agr. Bull.* 1429: 55 pp.

Clausen, C. P., 1940. *Entomophagous insects.* McGraw Hill, London. 688 pp.

Crosskey, R. W., 1973. A conspectus of the Tachinidae (Diptera) of Australia, including keys to the supraspecific taxa and taxonomic and host catalogues. *Bull. Br. Mus. nat. Hist.* (Ent.) Suppl. 21: 221 pp.

Evans, J. W., 1936. A new species of *Nysius* (Hem: Lygaeidae) from Tasmania and notes on the economics of the genus. *Bull. ent. Res.* 27: 673-676.

Keilin, D., 1944. Respiratory systems and respiratory adaptations in larvae and pupae of Diptera. *Parasitology* 36(1): 1-66.

Eyles, A. C., 1963. Some notes on the natural enemies of Lygaeidae (Hem.). *Entomologist's mon. Mag.* 98: 226-227.

Malipatil, M. B., 1970. The biology of some Lygaeidae (Hemiptera: Heteroptera) of South East Queensland. *Aust. J. Zool.* 27: 231-249.

Malloch, J. R., 1929. Notes on Australian Diptera. XIX. *Proc. Linn. Soc. N.S.W.* 54: 107-117.

Malloch, J. R., 1930. Notes on Australian Diptera. XXIII. *Proc. Linn. Soc. N.S.W.* 55: 92-135.

Thompson, W. R., 1922. On the taxonomic value of larval characters in tachinid parasites (Dipt.). *Proc. ent. Soc. Wash.* 24(4): 85-93.

Thompson, W. R., 1951. *A catalogue of the parasites and predators of insect pests.* Section 2, part 1. Commonwealth Institute of Biological Control, Ottawa, Canada.

Woodward, T. E., 1964. Preliminary note on the distribution of *Nysius vinitor* Bergroth and *Nysius clevelandensis* Evans (Hemiptera: Lygaeidae). *J. ent. Soc. Qd* 3: 85.